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AN ANALYSIS OF THE IMPACT OF ASPA ON ORGANIZATIONAL AND DEPOT LEVEL MAINTENANCE

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The Aircraft Service Period Adjustment (ASPA) Program was designed to determine the need to induct an aircraft into Standard Depot Level Maintenance (SDLM) based on Period End Date (PED), material condition, flight time and other factors in order to determine if the SDLM could be deferred for one year before reinspection and/or induction. If the SDLM is deferred, the expenditure of depot funds for an aircraft is deferred in the current year.

Initially, the program allowed for the extension and deferral of numerous aircraft and did produce a one time saving. However, it has been observed that deferring SDLM, results in the deterioration in aircraft material condition. More over, ASPA brings significant uncertainty in depot parts support and SDLM planning and scheduling. ASPA causes a redundancy of effort in duplicating the aircraft inspections for ASPA and for induction into SDLM.

In this research we show that the termination of the ASPA Program will significantly reduce the uncertainty and variability inherent in the Navy depot induction process. With the variability reduced turnaround time, organizational and depot workload, man hours expended and total costs will be improved.

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AN ANALYSIS OF THE IMPACT OF ASPA ON ORGANIZATIONAL AND DEPOT LEVEL MAINTENANCE

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ABSTRACT

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LIST OF ACRONYMS

ACE	Aircraft Condition Evaluation
ACI	Analytical Condition Inspection
AFLC	Air Force Logistics Command
ASIP	Aircraft Structural Integrity Program
ASPA	Aircraft Service Period Adjustment
CFA	Cognizant Field Activity
CIE	Controlled Interval Extension
DOD	Department of Defense
DON	Department of the Navy
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FLE	Fatigue Life Expenditure
FMS	Foreign Military Sales
LES	Local Engineering Specification
MSIP	Multi-Staged Improvement Program
NADEP	Naval Aviation Depot
NALP	Naval Aviation Logistics Program
NDI	Non-Destructive Inspection
OM&N	Operations & Maintenance, Navy
OSP	Operating Service Period
P&E	Planning and Estimating
PDM	Programmed Depot Maintenance
PED	Period End Date
PM	Program Manager

RCM	Reliability Centered Maintenance
SDLM	Standard Depot Level Maintenance
SPM	System Program Manager
TARPS	Tactical Air Reconnaissance POD System
TAT	Turnaround Time
VIDS/MAFS	Visual Information Display/Maintenance Action Form
WUC	Work Unit Code

I. INTRODUCTION AND BACKGROUND

A. BACKGROUND

The Aircraft Service Period Adjustment (ASPA) program is centered on an in-depth inspection conducted by a depot level industrial P&E (Planner and Estimator) team to assess the material condition of an aircraft to determine if a Standard Depot Level Maintenance (SDLM) is warranted. The purpose of this evaluation is to provide a means of determining the need, based on material condition, flight time, Period End Date (PED) and other factors, to induct an aircraft for depot level maintenance. If the material condition warrants, the aircraft would be extended for one year before reinspection and/or induction. This Navy unique program was instituted in 1982 to provide a decision method whereby the induction of an airplane for depot maintenance is based on material condition as well as its Operating Service Period (OSP). By applying the ASPA process, depot induction deferrals have become a matter of routine.

Over the twelve years since the commencement of ASPA, there has been continuous budgetary pressure to defer depot inductions and the associated costs. Budget planners often saw ASPA as a means of deferring Operations and Maintenance, Navy (OM&N) costs in the current fiscal year. Additionally, these continued deferral decisions have not adequately addressed potential diseconomies such as the change in squadron workload, the requirements of aging aircraft, and the impact on aircraft material condition resulting from serial deferrals and the effect on depot work content. Moreover, the effect of ASPA in depot back shop support, inventory requirements and the increased production flow times has not been considered.

Empirical evidence in the field of Logistics Engineering all support the theory of a firm induction schedule as a means of assuring an efficient flow of aircraft to the depot. This firm induction schedule reduces budgetary uncertainty, turnaround time, uncertainty of parts support, and squadron workload. The process results in minimized

product variability, enhanced aircraft quality, and a reduced degradation of components. The Navy is unique in that the Air Force and commercial airline industry all employ a depot maintenance philosophy that adheres to inductions based on firm operating periods.

Navy squadrons, airwings and maintenance officers are under enormous pressure to avoid sending an aircraft to the depot for various reasons. Historically, the Navy is slow in replacing those aircraft inducted to the depot. When the aircraft is replaced, the squadron is then left, initially, with an unfamiliar asset. The squadrons often argue that the material condition of the aircraft dos not warrant sending it to the depot. The fleet considers the sailors' labor a free commodity and their efforts a small trade-off versus for inducting the aircraft to the depot. As a result, depot deferrals have become the rule rather than the exception. This practice has degraded aircraft material condition and increased the workload content for both the squadron and the depot. As a result of ASPA, the "over and above"unanticipated requirements in labor hours and materials SDLM work has increased, as well as SDLM turnaround times.

For those readers unfamiliar with Navy and Air Force maintenance, an introduction and detailed description of the services maintenance policies can be found in Appendix A.

Our study suggests that the Navy would be better served with a holistic maintenance approach that features a total life cycle plan associated with each aircraft bureau number. In this era of downsizing, the Navy needs to better manage the reduced number of assets available and such an approach could help.

B. OBJECTIVE

The primary objective of this thesis is to determine the effects that ASPA has had on Naval aircraft in three significant impact areas. The first is the impact of ASPA on depot rework material and labor costs and turnaround time. Secondly, the effect ASPA has had on the material condition of the aircraft. Finally, the impact ASPA has on the organizational level. Through our research, we will show that a firm depot more efficient alternative to ASPA.

The Air Force and the commercial airline industry both employ a Planned Depot Maintenance (PDM) concept to their respective depot maintenance philosophies. This PDM program inducts aircraft for depot level rework based on a set time, determined and adjusted based on empirical evidence and experience. Our research compares the Navy unique ASPA program to the firm depot induction schedule used by the Air Force and civilian airlines. This comparison will show the contrast between ASPA and PDM as well as document the significant impact ASPA has had on Navy maintenance.

The termination of the Navy's ASPA program could significantly improve budget planning, reduce costs for depot level maintenance and eliminate an uncompensated workload increase at the squadron level. By strictly adhering to operating periods, the uncertainties and variabilities brought about by ASPA will be eliminated.

C. SCOPE

This thesis is concentrated on the impact of firm induction schedules as compared to depot induction deferrals. Specifically, the focus will be on material and labor costs, schedule impact, material condition and parts support for Naval aircraft under the Navy's ASPA program, with emphasis on the F-14 Tomcat and the Air Forces' F-15 PDM program.

Through our research, we expect to determine that ASPA should be eliminated and a firm induction schedule, like PDM, is the viable alternative. This thesis will assist in any future decision to evaluate ASPA as a depot maintenance philosophy through the documentation of the consequences of the program on Navy depot and organizational level maintenance.

D. PREVIEW

Chapter II will discuss the procedures for the ASPA and PDM programs. Specifically, we will discuss depot maintenance induction procedures for the Navy's

F-14 Tomcat and the Air Force's F-15 Strike Eagle.

Chapter III will compare the ASPA and PDM induction processes. Additionally, an explanation of the commercial airlines and the P-3 prototype program will be provided.

Chapter IV will analyze the ASPA and PDM data for the F-14 and F-15. A discussion of the trends in budget costs, depot completions and ASPA deferral rates from fiscal years 1991 to 1994 will be provided.

Chapter V will be the summary, conclusions and recommendations.

II. THE PDM AND ASPA PROGRAMS

A. DEFINING THE PDM PROGRAM

1. Introduction

The Air Force utilizes the Programmed Depot Maintenance (PDM) concept for scheduling all aerospace vehicles and training equipment for depot maintenance. The Air Force Technical Order (TO) 00-25-4 outlines specific procedures and guidelines for the induction of all Air Force regular and reserve aircraft.

The maintenance engineering objective is to ensure the most timely and economical means are utilized in order to achieve the most mission capable aircraft. The Air Force operational objective is to ensure that the depot pipeline of inductions does not severely impact readiness for available aircraft. The criteria used for meeting this objective includes a comparative analysis of costs and benefits to the Air Force Logistics Command (AFLC).

The AFLC is responsible for the management of the Air Force's Depot Maintenance program for all aerospace vehicles and training equipment. The item manager or Program Manager (PM) is responsible for the planning and scheduling of depot maintenance for their respective programs.

The Program Manager analyzes a variety of data sources as shown in Figure 1 to determine the correct maintenance practices in support of his program. His decisions are based on operational availability as well as the integrity of the material condition of the aircraft.

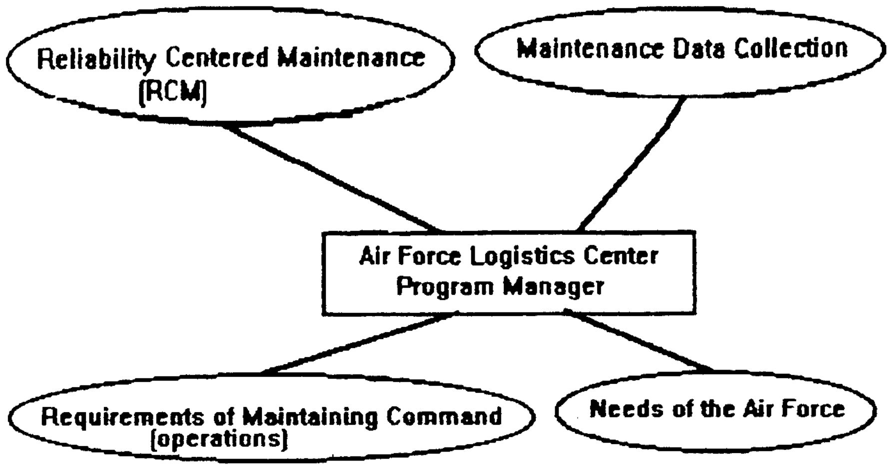

Figure 1. The AFLC as the Logistics Hub

These sources of maintenance data depicted in Figure 1 are evaluated to derive the most optimal depot maintenance cycle. The TO states "except for unplanned emergency requirements, depot maintenance will be based on a Maintenance Plan and set intervals. *This steady state scheduling of maintenance facilitates the programming of depot dollars, material requirements, manpower requirements and facility requirements."* (AFTO, 1985)

Air Force field depot maintenance is only conducted if it justifies reducing the aircraft's out of service time, or is severely hampering the units mission capability. Only if field team maintenance can be advantageous to the government is it justified. Otherwise, the field depot repair can be postponed and conducted on the next depot maintenance interval.

2. The PDM Process

The PDM cycle is centered on the firm induction of aircraft based solely on calendar time. The cycle is firmly established on months of service and is measured from the output date of the last PDM to the input date of the next PDM due. Figure 2 depicts the time line in which the PDM process works. A deviation of plus or minus 90 days is allowed from the actual PDM due date. Failure to specifically follow the

instructions outlined in the TO will result in the grounding of the aircraft, with the exception of a one time flight to the depot.

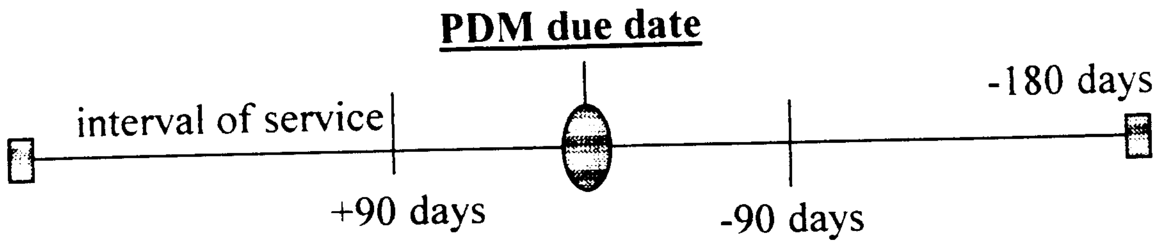

Figure 2. The PDM Cycle

The System Program Manager (SPM) in coordination with the organizational controlling custodians, determine the depot maintenance requirements for each fiscal year of service. These maintenance plans include future and all planned maintenance actions in the coming months/years.

These maintenance plans written by the SPM are extremely detailed and are rigidly followed. These plans include:

1. Items of maintenance not associated with depot requirements but need to be included in the specific guidelines. These include such items as: economy of maintenance modifications, safety of flight and negotiated maintenance/modifications.
2. Engine specific information to be used for planned repair/replacement at the depot.
3. All engine maintenance requirements to include the next due major aircraft inspection tasks, and the correction of Safety of Flight (SOF) defects. (AFTO, 1985, pg. 13 CH. 4)

The maintaining command can negotiate with the SPM for certain maintenance to be accomplished concurrent with PDM to ease the burden on the organizational level. Additionally, the Air Force does allow for incorporation of modifications and inputs to be performed by field maintenance. This is only done when modification priorities and availability of kits or facilities are incompatible with PDM cycle.

The established intervals for depot maintenance have been ascertained through experience and expertise in the maintenance arena. The interval is derived by allowing the material condition of the aircraft to pace the PDM cycle. It can only be adjusted by the (SPM) based on their technical expertise and authority. The SPM, as the maintenance engineering and logistics manager, is the only one qualified who can determine a safe extension of the PDM cycle.

The SPM, in coordination with the maintaining command develops input and output schedules for PDM based on the needs of both the maintainer and operator. The user guarantees that sufficient aircraft are retained in order to accomplish their mission, and the SPM ensures that all scheduled PDM aircraft are ultimately inducted.

Once the SPM has outlined the program, it is then forwarded for approval by the AFLC. When it is approved, copies of this plan are forwarded to the major commands and user activities. This maintenance plan is a hard and fast plan that is adhered to by all involved with that particular weapons system.

3. The Controlled Interval Extension (CIE) Program

The objective of the CIE program is to give the logistics manager in charge of a weapons system, some latitude in changing the PDM intervals or work requirements. The logistics manager has maintenance information on the aircraft from maintenance data history , the requirements from the maintaining command and the needs of the Air Force to adequately determine the proper interval for PDM.

The SPM is charged with scheduling Analytical Condition Inspections (ACI) on representative sampling of his particular weapons system. The TO gives specific guidance on sample sizes to be inspected as well as specific parameters for isolated defects in 20% or more of the aircraft with a 90 percent confidence level. (AFTO, 1985, pg. 1-1, CH. 4)

Additionally, a periodic review and evaluation of the current PDM interval is conducted on a regular basis to determine and reiterate the rational behind the length of the set interval. The logistic tools for this evaluation are the ACI and the ASIP.

An ACI is an in-depth systematic disassembly and inspection of representative aircraft to uncover hidden defects that are undetectable through normal inspection programs.

The ASIP is a procedure applied to an aircraft system to enhance design, diagnose potential or impending structural failure. These inspections include non-destructive inspections (NDI). If the ACI and the ASIP data warrant that PDM extensions are not feasible for this aircraft, the CIE program for that weapons system will not be considered.

When a weapons system PDM interval is evaluated and ultimately extended under the CIE program, then upon its induction, it will be scrutinized to determine the positive or negative effects of the extension. This analysis will then be used in establishing future inspection requirements and PDM intervals.

4. The F-15 PDM Program

The F-15 aircraft is a dual engine fighter aircraft utilized by the Air Force primarily in an air superiority role, with secondary attack functions. Manufactured by McDonnell Douglas, the initial prototypes were flown in the early 1970's with the first aircraft going to the Air Force in 1979. The last USAF F-15 A/B/C/D was delivered in 1989 with the production resuming in 1991 for the Foreign Military Sales Program (FMS).

The center for depot maintenance for the F-15 is Robins Air Force Base located in Warner Robins, GA. Robins AFB is Georgia's largest industrial complex, covering more than 8,790 acres. One of five Air Logistics Centers located throughout the country, Robins provides cradle to grave logistics management support and depot level maintenance for the F-15, C-141 and the C-130 aircraft. (AFMC, 1994)

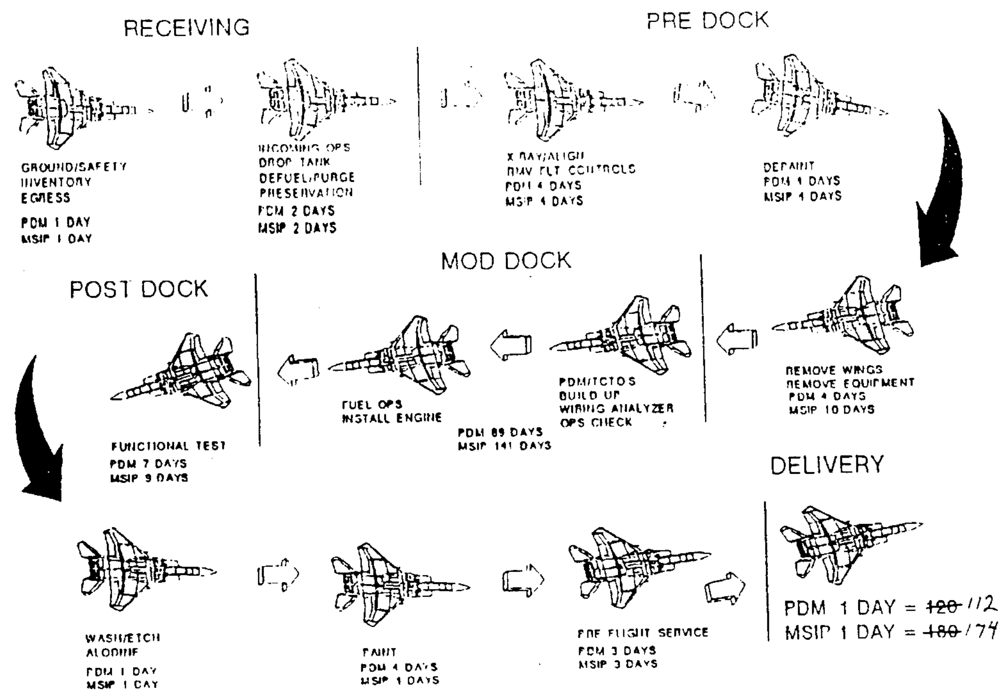

Figure 3. F-15 Flow Diagram

The F-15 logistics managers have utilized planned depot maintenance intervals throughout the entire life cycle of the aircraft. Figure 3 displays the flow days for a complete PDM cycle. The Multi-Staged Improvement Program (MSIP) is an upgrade for the aircraft that includes: improved central computer processing speed, multi-purpose color display, internal countermeasures, and improved radar. Total flow days for a PDM only aircraft are 112 days, with MSIP improvements 174 days.

B. THE ASPA PROGRAM

1. Introduction

ASPA was instituted in 1982 by Naval Aviation Logistics Center (NAVAVNLOGCEN). ASPA is an in-depth inspection conducted by a depot level industrial P&E (Planner and Estimator) team to access the material condition of an aircraft to determine if a SDLM is warranted. The purpose of this evaluation is to provide a means of determining the need, based on material condition, flight time, Period End Date (PED) and other factors, to induct an aircraft for depot level maintenance. If the material condition warrants, the aircraft would be extended for one year before reinspection and/or induction.

The ASPA program recognizes that aircraft material conditions do not deteriorate at the same rate. These degradations are functions of carrier landings, operating environments, catapult launches, operating cycles, and the quality of the routine maintenance performed. All these factors are evaluated at the time of inspection to determine whether SDLM for that particular bureau number can be safely averted to the following year.

The predecessor to the ASPA program called Aircraft Condition Evaluation (ACE) was instituted by the Department of the Navy (DON) in the early 1970's. Unfortunately, introduction of the ACE program significantly increased organizational maintenance man-hours, and revealed less than optimal results; therefore, an unacceptable number of fleet aircraft were in a non-flight status for extended periods of time. (Borchers and Rowan, 1986)

Despite the failure of this initial program there still was a legitimate need from an operational standpoint to keep aircraft not seriously degraded from the depot cycle. It provided an orderly deferral of unwarranted SDLM's and also appeased the airwings in keeping aircraft in service longer. The ASPA program is used on most Naval aircraft today.

The ASPA program was designed to correct the mistakes of the ACE program and alleviate the operational burden placed on the squadrons. The organizational levels in the fleet are performing work that, due to levels of skill and expertise, should be performed in the depots. This trend has grown as the ASPA program keeps aircraft in the squadrons longer and places more of the maintenance workload on the backs of the sailors. Many people incorrectly consider sailor labor free commodity, but it actually costs the Navy significantly for their increased effort.

This trend is a significant negative aspect of the ASPA program and is a serious consideration that should be addressed in determining its future in Naval maintenance.

2. ASPA Inspections and Inductions

All aircraft when placed into service in the fleet are assigned a Period End Date. This PED is a determination of the best interval of months for the aircraft to remain in service before being inspected for consideration for a SDLM overhaul. Historically, the end of the Operating Service Period (OSP) was indicated by the PED. The OSP for the F-14 is 56 months, however with ASPA, the OSP is actually seven years before the aircraft is inducted into the depot. The conclusion of the OSP prior to ASPA signaled the need for SDLM rework to be performed. ASPA changed this perspective from an "on time" to an "on condition" method of depot maintenance.

Figure 4 depicts the time frame reference for the ASPA process. An aircraft's material condition is evaluated normally six months prior and nc ;ater than three months after the PED. The deferral if granted is for a maximum of twelve months. Aircraft failing ASPA must be inducted no later than ninety calendar days following PED. Those aircraft recommended for extensions of their PED's may have an unlimited series of aircraft material condition evaluations and deferrals. (Borchers and Rowan, 1986)

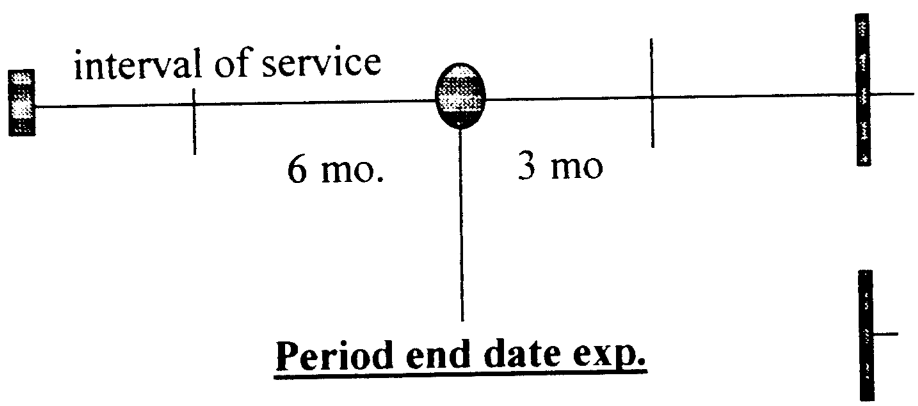

Figure 4. The ASPA Induction Process

The Cognizant Field Activity (CFA) for each aircraft subject to the ASPA program shall establish procedures and criteria to be used to certify ASPA evaluators. The CFA maintains control and monitors the effectiveness of these evaluators to

maintain a proficient, rapid and objective assessment of the general material condition of aircraft candidates for rework. (OPNAVINST 4790.2E, 1991)

The ASPA inspectors are specialists from the depot who are dispatched to perform the inspection of the aircraft. Utilizing the Local Engineering Specification (LES), a thorough examination of the aircraft's maintenance history is performed in addition to the actual physical inspection. The inspector uses s grading system to evaluate the aircraft. Discrepancies are categorized as critical, major or minor and an overall point total is assigned the aircraft. Based on the total points accumulated, the aircraft either passes or fails the inspection. Visual Information Display System/Maintenance Action Forms (VIDS/MAFS) are generated on the aircraft and the organizational level or depot field teams performs the repair based on the severity of the discrepancy. Should the aircraft fail, a one time flight to the depot is authorized and the VIDS/MAFS accompany the aircraft to become part of the SDLM work package.

3. The F-14 ASPA Program

The F-14 aircraft is a supersonic twin engine, two seat, swing wing air superiority fighter that was designed and produced by Grumman Aerospace Corporation. The F-14 Tomcat can handle numerous missions including air superiority, Fleet Air Defense, and Tactical Air Reconnaissance Pod System (TARPS) reconnaissance. The F-14A had been in the fleet for about eight years prior to ASPA.

The F-14 ASPA procedure follows exactly the same procedure outlined above. The Period End Date for the F-14 is set at 56 months. This 56 months does not equate to calendar time but rather 56 months of operating service. The end of this PED is the signal for the start of ASPA evaluations.

C. PREVIEW

Chapter III compares the ASPA and PDM induction processes. Specifically, we will discuss the consequences of ASPA on the material condition of Naval aircraft, operational pace, and the organizational and depots levels maintenance efforts. Additionally, we will explain the commercial airlines and the P-3 PDM prototype program.

III. COMPARISON OF ASPA AND PDM PROCESSES

A. BACKGROUND

Before we can analyze and compare the two processes, we must first understand the reasons why an aircraft is inducted into the depot They are inducted for four reasons: The first reason is the engineering considerations to maintain the fatigue life expenditure (FLE) to perform special structural inspections as set by Navy engineers. The second reason is that the material condition of key elements in the airframe degrade with extended use. The engineering considerations are hard and fast requirements for induction and never optional. The third reason is for the engineers and technicians at the depots to maintain the skills necessary to conduct in-service engineering, promulgate grounding bulletins, design correction criteria, and certify aircraft safe for flight after grounding. The final reason is that the depot possess the technical expertise, tools and facilities to perform such extensive work.

B. CONSEQUENCES OF ASPA

Recently, questions have arisen as to the original intent of ASPA, specifically, the aircraft material condition has been outweighed by the increasing SDLM material and labor costs. This is due to the deteriorating condition of the aircraft as they get older. On average, an F-14 is in the fleet seven to eight years before it is finally inducted into SDLM. Discussed further in chapter four, this equates to an aircraft passing, on average, three ASPA's before it finally fails. The longer an aircraft stays in the fleet, the more it requires additional maintenance and parts "over and above" the SDLM work package specification. As the aircraft ages, more airframe maintenance is required. As an example, the depots are experiencing an increase in delaminations on F-14 control surfaces the longer the aircraft remains in the fleet. This problem has deteriorated to the point affected parts must be remanufactured during SDLM. This contributes to an increase in turnaround time (TAT) at the depot.

As shown in Figure 5, TAT in workdays has increased over the last three fiscal years. This "over and above" work during SDLM correlates to an increase in cost resulting from more material required (new or remanufactured) due to greater wear or because of overall degraded material condition and additional man-hours required to complete the depot maintenance. Figure 5 shows a present average TAT of 267 days with significant variability as compared to an F-15 PDM of 112 days with insignificant variability.

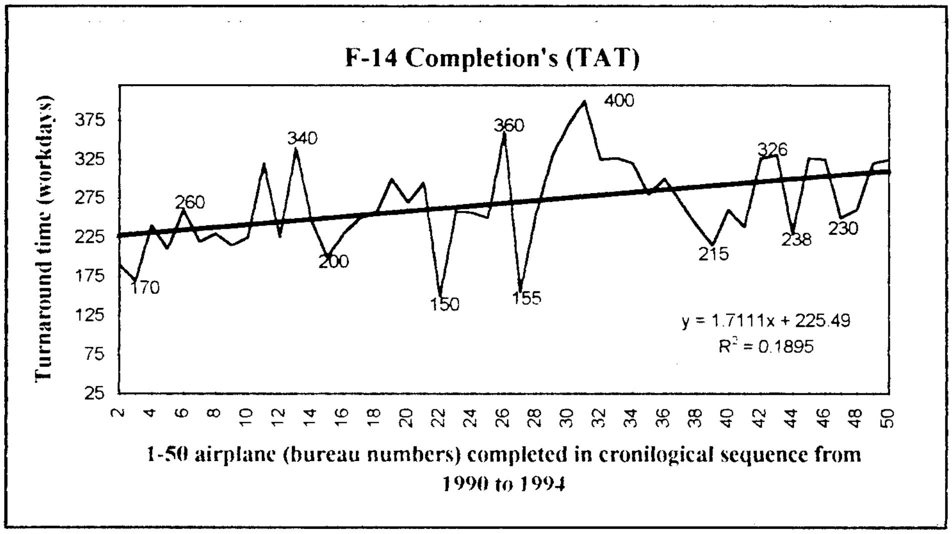

Figure 5. SDLM TAT in Work Days

In Figure 5, the data shows a very low R^2 value with the trendline having a slight upward slope. Although there seems to be an increasing trend in TAT over 1990-1994 as shown in Figure 5, the regression line is not meaningful with an R^2 value of 0.1895. However, the minimum and maximum points run from 150 to 400 work days with a range of 250 days as examples of the extreme variability for an aircraft to complete SDLM. This variability in TAT would lead you to conclude that the the depot will suffer from unanticipated parts demands with associated delays and other factors such as unplanned back-shop requirements that could potentially delay the completion of SDLM. Both graphs depict the uncertainty experienced by the

squadrons and airwings in receiving completed aircraft from the depot. This uncertainty explains the disincentives for the squadron and airwings to give up a known asset.

1. Defense Budget Climate

The current defense spending plays a critical role in the way the Navy continues to conduct its maintenance programs because of the tension between budget and maintenance requirements. The President is seeking $250.7 billion in DoD budget authority for fiscal year 1994. This is an $8.4 billion below the budget passed by Congress for fiscal year 1993. This is a 8.5 percent decline adjusted for inflation. Figure 6 shows the Department of the Navy (DON) budgets fror 1985 to 1994. (Vanderwende, 1994) As the DON budget decreases, the costs of SDLM shows a steady increase in pressure on that budget.

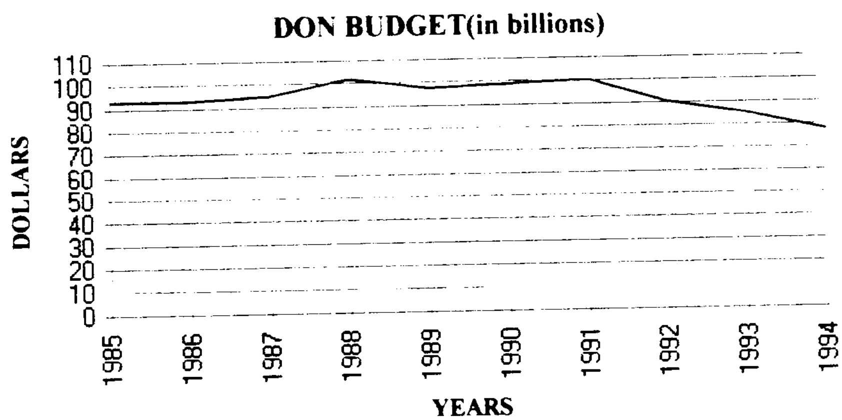

Figure 6. DON Budget

Figure 7 displays the depot rework budget from 1985 through 1994. We can see in Figure 7 that the depot rework budget is also declining at the same rate since 1991.

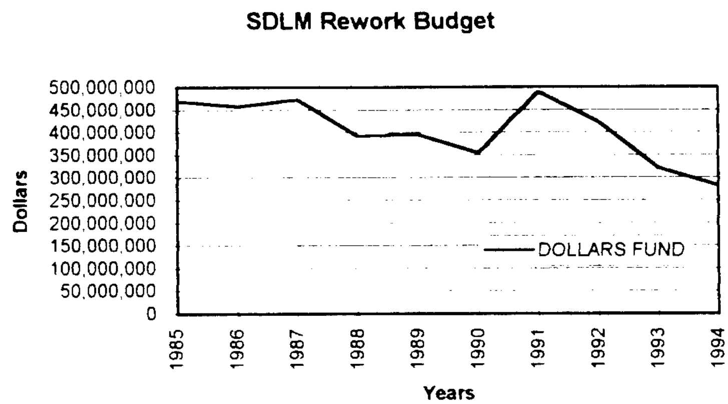

Figure 7. Depot Rework Budget

2. Cost Impact

By the year 2000, DoD will reduce the F-14 fleet to a core force of approximately 251 aircraft. With a fewer number of assets in the aviation community and an aging fleet of aircraft, the Navy needs to manage the existing aircraft with more cost efficient maintenance schemes. DOD is no longer acquiring new F-14 aircraft. For the remaining F-14 fleet, we need to reduce the variabilities in material support, labor content, and budget manning. The focus should now be on putting the SDLM process in control and not continuing to defer cost requirements into the future. The Navy can no longer afford to keep doing business the way it is doing with the ASPA program. In Chapter IV, we will show a projection analysis through the year 2000 on the cost of continuing the ASPA program. This projection demonstrates a steady increase in the cost of ASPA through the year 2000.

The material cost of SDLM has increased from $300,000 in fiscal year 1990 to approximately $600,000 in fiscal year 1994. This figure has almost doubled in four years. Figure 8 displays the increase in F-14 SDLM material cost over the last four years.

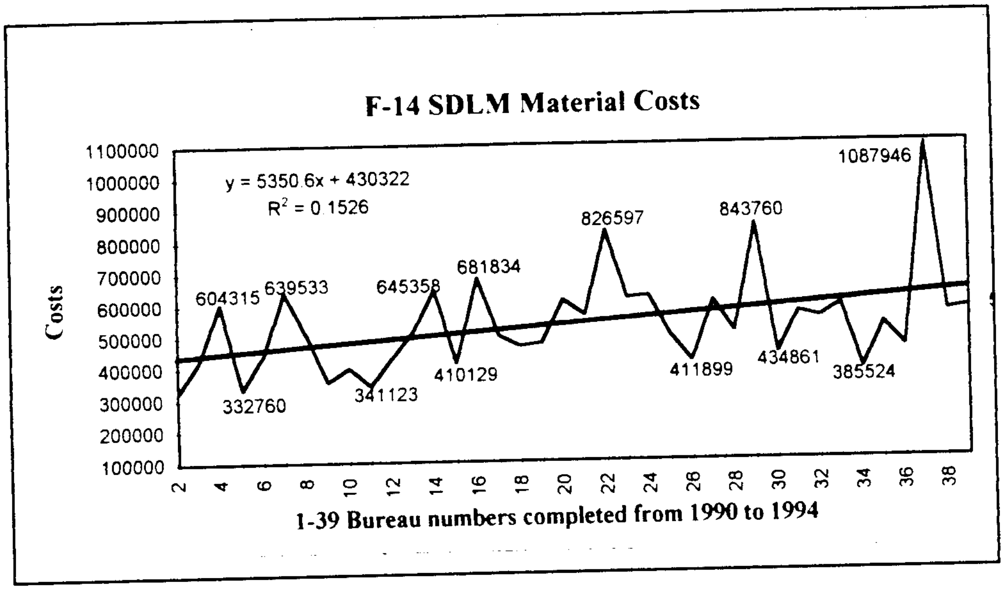

Figure 8. F-14 SDLM Material Costs

Figure 8 exhibits the SDLM material cost data on 39 bureau numbers which completed SDLM from 1990-1994. The minimum and maximum points in Figure 8 run from $258,875 to $1,087,946 displaying the extreme variability in material costs for aircraft completing SDLM. This variability is due to the "over and above" material used by the depots, specifically, raw materials in the remanufacture of parts to return the aircraft to proper material condition. Although there seems to be an increasing trend in material costs over 1991-1994 as shown in Figure 8 , the regression line is not meaningful with an R^2 value of 0.1526.

Additionally, the SDLM budget is shrinking every year. This change in material cost is a direct result of the deteriorating condition of the aircraft as a result

of ASPA. Inflation is also a small part of this cost increase. For example, horizontal stabilizers in 1991 cost approximately $150,000/ stabilizer and in 1994 cost $322,000; the cost doubled in three years. Additionally, in 1991 the Aviation Supply Office (ASO) placed a 22 percent surcharge on its stock fund repairables. This coincides with the decreasing DOD budget as previously discussed in the beginning of this chapter. The continuing budget cuts and down-sizing initiatives mandate positive actions to reduce costs in the Navy.

This increase in the total SDLM cost is comprised of, not only an increase in materials, but an increase in the cost of labor required to perform the SDLM. The labor rate has shown an increase over the last four years.

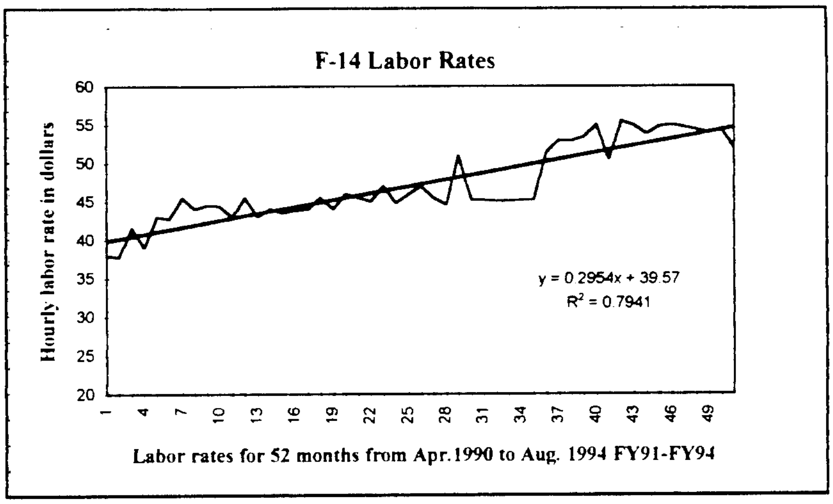

Figure 9. F-14 SDLM Labor Rates

Figure 9 shows an increase in the SDLM labor rate of $44.35 in fiscal year 1991 to $53.83 in fiscal year 1994. These figures are in then-year dollars. This labor rate increase contributes to the increase in the total cost of SDLM. Of the total labor and material rate, a portion includes inflation. The other portion consists of the additional raw materials required to remanufacture the parts as a result of the deteriorated condition due to ASPA. The R^2 value of .78 shows a strong relationship that the labor rate has been increasing each year. This increase in labor rate added to the increase in man-hours are key factors in the increase cost of SDLM.

The expended hours for SDLM has increased from fiscal year 1991 to fiscal year 1994. Figure 10 shows an increasing trend in hours expended for current SDLM's.

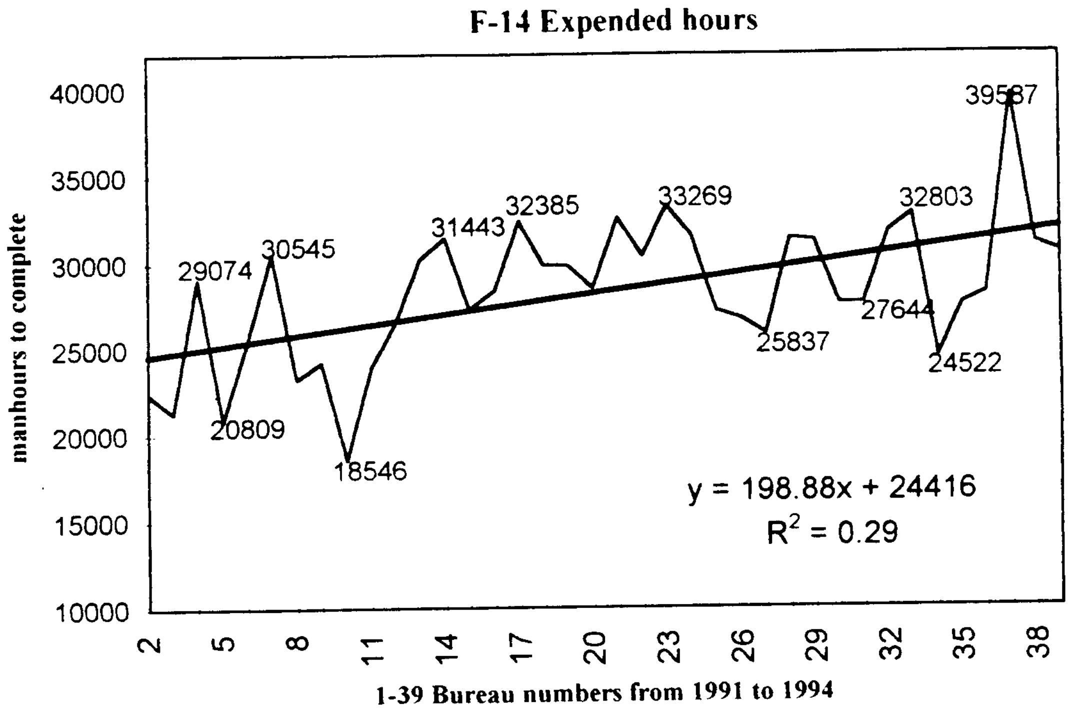

Figure 10. F-14 SDLM Expended Hours

Figure 10 shows the extreme variability in hours expended to complete SDLM. The time to complete an aircraft SDLM runs from a minimum of 18,546 man-hours to a maximum of close to 40,000 man-hours. This variability in man-hours is consistent with the TAT data in Figure 5.

3. Impact on Organizational Level Maintenance

The impact that ASPA is having on organizational level maintenance is significant. As discussed in the previous chapter, the Navy has changed the procedures for depot level maintenance due to ASPA, but no changes were made at

the organizational or intermediate levels. No significant change was ever made to the SDLM specification or organizational level maintenance corrosion requirements to compensate for the extended service periods. We are tasking our sailors to perform depot level maintenance by leaving the aircraft in the fleet longer. For example as the aircraft gets older and the material condition degrades, sailors have to perform more preventive corrosion work. Due to their lack of technical expertise, their treatments of corrosion can actually further deteriorate the condition over time. Now, the organizational level maintenance technician has to perform more corrosion work than his technical experience or skills allow. As the aircraft are continually spot painted by the squadrons, the aircraft take on a "leopard" appearance, this sacrifices the corrosion integrity of the aircraft. The end result is more work for the depot. This increase in depot workload correlates to a longer turnaround time (TAT) for the aircraft as shown in Figure 5. It takes approximately 100 organizational man-hours just to prepare an aircraft for an ASPA inspection and 32 depot man-hours to actually inspect the aircraft. Maintenance data does not reveal or code time expended by the squadron to repair anticipated ASPA discrepancies which would be significant. If an aircraft fails the ASPA inspection and has to be inducted into SDLM, these man-hours have been useless. Instead of sailors expending these man-hours reading the aircraft for inspection, the organizational level maintenance technicians could be working on other aircraft in preparation for the flight schedule.

It is important to note that the ASPA process has made depot induction subjective. Although it was not the original intentions of the ASPA program, it is a "badge of honor" to a maintenance technician for the squadron to pass an ASPA inspection. For the aircraft to fail the ASPA inspection, there is a sense of "failure" felt by squadron maintenance personnel. As a result of this thinking, the ASPA program has made the SDLM process a subjective one and thus making the decision to induct the aircraft more difficult.

The turnaround time for SDLM inductions at the depots are so excessive that squadron replacements are slow. This leads to increases in the workload for the

sailors in the squadron that squadrons are under tremendous pressure to avoid SDLM inductions. They are now forced to perform depot level maintenance tasks with only organizational level expertise. As the ASPA deferrals increase, this creates an additional SDLM workload increase and places a burden on the depot. The depot now has to correct the work performed by organizational level technicians who do not possess the depot skill or expertise to perform the work. The ASPA program, as a whole, has had a significant impact on both the organizational and depot level maintenance and materials and scheduling, TAT and parts support by increasing the variability of the process.

4. Planning and Scheduling

The ASPA program makes the planning and scheduling process extremely difficult at both the depot and the organizational levels. There is a the high degree of variability or uncertainty regarding the labor required, material required and the number of aircraft inducted into SDLM each year. With the ASPA program, there can be no established schedule for inductions each year. Therefore, no accurate planning or forecasting can be made regarding the number of SDLM's the depot can expect. The Navy needs a method to track and maintain each aircraft it owns. There really is no long range planning associated with each aircraft bureau number. This process, currently, can only be conducted based on the aircraft's PED expiration for that fiscal year. However, the ASPA program introduces a considerable amount of variability into this process. One cannot predict which aircraft will pass ASPA until the P&E evaluator inspects the aircraft. This will continue to be a problem until there is some firm induction period for the F-14 or any other Navy aircraft. The firm induction schedule, like the PDM process, will alleviate any planning or forecasting for the squadrons and depots and eliminate variability from this process. Everyone in the aircraft's chain of custody will be fully aware of which aircraft will be inducted and when. This schedule can be published for a multiple year period and facilitate long range planning.

NADEP Norfolk, VA currently utilizes the NORMS system to determine workload standards, material standards and planned turnaround times for aircraft and engines under the SDLM program. This system is a way to plan and estimate the man-hours required, based on historical data, to perform an F-14 SDLM during a given year. In the next chapter, we will show that this current system has a extremely high variability. In our sample size of 39 bureau numbers, every completed SDLM was underestimated in man-hours to complete the SDLM.

The depots hire their work force by the number of SDLM's they expect each year. If they hire personnel for an upcoming SDLM and the aircraft is deferred, this can be very costly to the depot. This uncertainty, created by ASPA, places a burden on depot planning for manpower front loading for SDLM scheduling. The steady state inductions that PDM provides will save money. The PDM process allows for less variation in planning, workload and parts support which results in a cost savings. Scheduling and planning is relatively easy with consistent, dependable time frames for inducting all aircraft by bureau number.

5. Aircraft Material Condition

Aircraft material condition degrades as the number of ASPA deferrals increase. This degradation, over time, drives costs higher. It also creates an additional workload above and beyond the standard requirements of SDLM. In the past, the depots would complete F-14 SDLM's in 100 days. Now it takes, on average, over 267 days to complete. Chapter IV documents the material cost increases as the material condition decreases. This is as a result of the aircraft aging as well as the deterioration of 58aircraft being deferred for SDLM due to the ASPA program. For example, the F-14 flight controls, specifically auxiliary flaps and speed brakes, are being remanufactured during the SDLM process. Because the SDLM is deferred, the aircraft's material condition deteriorates the longer it is exposed to the aggressive environmental conditions of carrier deployments and the rigors of fleet operation.

F-14 depot inductions show that the more ASPA deferrals the worse the condition. Delamination problems on flight control surfaces add a total of 7000 hours to the

SDLM process. This equates to a portion of the "over and above" cost, material and turnaround time of SDLM. These structure problems combined with the increase in turnaround time results in an increase in pipeline aircraft. This makes planning and scheduling difficult. Controlling the aircraft's material condition and thus controlling planning for resource requirements must drive the SDLM process.

6. Subjectivity of ASPA Inspections

The ASPA inspection is conducted according to the F-14 Local Engineering Specification (LES) . The decision to induct an aircraft for SDLM is based on the ASPA inspector's subjectivity and not actually based on flight hours or calendar time. The LES provides a detailed comprehensive checklist of items and areas to be inspected in determining whether the aircraft is inducted in to SDLM or deferred for a year. The P&E team uses the LES during each ASPA inspection and records the discrepancies. Once complete, the P&E inspection team assigns the discrepancies a defect code of major, minor or critical. These defect codes are delineated in the LES.

When the entire evaluation is completed, the P&E team totals the number of graded discrepancies and subjectively determines the overall condition of the aircraft. There are some inherent problems associated with this inspector subjectivity. The P&E evaluation has significant personal investment and all noted discrepancies are judgemental. The tendency is for the P&E evaluation to be more personality driven than technical. The P&E inspector, through technical knowledge and work experience, determines the level of maintenance required to repair the noted discrepancies. The levels of maintenance that are possible include the organizational level and the depot. Based on this determination, the P&E inspector recommends the aircraft remain in the fleet or induct the aircraft in to the depot for SDLM.

When an aircraft fails an ASPA inspection, the P&E inspector together with the squadron and airwing, discuss the aircraft condition and determine the impacts of inducting the aircraft in to SDLM. The squadrons and airwings are under enormous

pressure to avoid sending an aircraft to SDLM because the Navy has been historically slow in replacing the aircraft. It can take approximately six months to receive a replacement aircraft and sometimes longer.When the squadron finally receives an aircraft, it is an unknown asset. The fleet is under the misconception that a sailor's labor is free and is a resource to avoid aircraft induction into the depot. Moreover, they retain a known asset. With this pressure and influence, the P&E inspector can defer a SDLM on a borderline aircraft. This subjectivity in inspections can cause severe problems when a borderline aircraft is continually deferred. This inspection subjectivity creates future impacts by passing problems to the squadron in the way of increased workload, unskilled technicians repairing depot level discrepancies. They also further impact the eventual depot induction by introducing uncertainty in scheduling, parts support, increased TAT, and additional costs and material in the SDLM process. This subjectivity in ASPA inspections creates problems in the short and long runs. As ASPA discrepancies promulgate from minor to major, the material condition of the aircraft degrades to a point where it is no longer cost effective to remain in the fleet. NADEP Norfolk, VA. recently had an aircraft pass ASPA inspection number five! *This aircraft had been in the fleet for almost ten years without a SDLM.*

C. CIVILIAN AIRLINE MAINTENANCE POLICIES

It is important to examine how the major civilian airlines schedule their major aircraft inspections and maintenance in a cost critical environment. For the purpose of this discussion, the major airline contacted was Delta Airlines. The major airline maintenance policies are governed by the Federal Aviation Administration (FAA) under the Federal Aviation Regulation (FAR) part 121. FAR requires a certificate holder to establish and maintain a system that analyzes and surveys the performance of its' maintenance and inspection programs on a continuous basis. The initial aircraft maintenance requirements are determined by the aircraft manufacturer. Any changes to these intervals are determined by the airline and require FAA approval. The

airlines develop their own basic guidelines under the auspices of the FAR part 121. Their governing instruction for aircraft maintenance is called "Standard Practice". It is a set of basic guidelines for aircraft maintenance policies and inspection intervals approved by the FAA. It also establishes a time line for individual component inspection intervals.

Delta Airlines schedules their aircraft inspection intervals based on flying hours. This correlates to the concept of a firm induction schedule similar to PDM. The civilian airlines firm induction schedule for complete overhaul in continually reviewed and analyzed for process modification. This analysis and adjustment of the interval is similar to the Air Force's Controlled Interval Extension Program. In these cases, the material condition and logistics data drive the maintenance interval, which is a sound practice as these logistics factors are dynamic and ever changing.

They conduct "progressive checks", or termed daily inspections by the Navy, on the flight line over night. Delta also performs "letter check" inspections, A,B,C and E, similar to the phase maintenance inspections in the Navy. These "letter checks" are completed in one week or less at the hubs in Dallas, TX., Tampa, FL. and Los Angeles, CA. Delta's complete aircraft overhaul is conducted on a calendar interval based on type/model aircraft. Atlanta, Georgia is the overhaul point for Delta Airlines. This entire rework process takes a maximum of *three to four weeks*. (Bauer, 1994) For example, a Delta 727 aircraft is completed in less than 20 days using a 20 man crew, working three shifts, seven days a week. This compressed rework schedule is to keep aircraft downtime at a minimum because of the loss in revenues when an aircraft is out of service. All airlines must carefully scrutinize their overhauls during the peak summer travel season in order to maximize aircraft availability.

D. WHY UTILIZE PDM?

Empirical evidence in the field of logistics engineering shows the theory of a firm induction schedule as a means of assuring an efficient flow of aircraft to the depot. Both the Air Force and the commercial airline industry dictates the use of only

the most cost efficient means of conducting an overhaul. Both the Airlines and the Air Force realize the importance of not deviating from a set induction schedule. The positive effects of PDM is improved material condition, operational availability and provide the best return on depot investment. PDM minimizes uncertainties in scheduling, planning, labor and material.

PDM has been designed as a cost effective, viable program to replace SDLM/ASPA deficiencies by targeting material condition and corrosion areas that have deteriorated from a continuous deferral of depot maintenance requirements. The PDM process increases the frequency of corrosion treatment and prevention to facilitate improved reliability in maintenance derived from the aging F-14 fleet.

E. THE OBJECTIVES OF PDM

The PDM concept is synonymous with steady state or firm depot induction process. The objective of PDM is to provide a firm depot induction schedule based on aircraft airframe and component requirements. The depot induction schedule can be determined through an reliability centered maintenance (RCM) analysis of the individual components and the airframe. As a result, the aircraft material condition will be significantly improved. PDM will enhance reliability in maintaining the aircraft airframe and its components.

The escalating organizational level workload will be reduced with PDM. Depot level maintenance will be returned to the depots. No longer will organizational level technicians be burdened with the responsibility of performing maintenance beyond their capability. The organizational level requirements must be changed to facilitate PDM and effectively sustain aircraft material condition. Organizational level maintenance workload continues to escalate. PDM gives the Navy a better return on its' depot investment through a better depot product and an increase in the aircraft service life. This is important in the era of down-sizing and reduced assets.

The PDM program will ease the forecasting in scheduling and planning at the depots through a firm induction schedule. The squadrons and airwings will know,

with relative ease, when an aircraft will be inducted, when a replacement can be expected and plan accordingly. PDM also provides for a cost savings through the elimination of ASPA. The PDM program enables a reduction in the scope of SDLM. The redundant tasks are eliminated as well as certain organizational level tasks. Additionally, PDM reduces concurrent component repair. PDM has shown that component life cycles do not coincide with the current SDLM cycle. The PDM program is designed to reduce these negative trends in organizational level workload increase, SDLM TAT, cost uncertainties in parts support and scheduling.

F. THE P-3 PDM PROTOTYPES

The Navy P-3 program is currently conducting a prototype program on four P-3 aircraft. The initial analysis began in 1989 for the PDM program on the P-3 aircraft. The reasons for this change in depot maintenance philosophy, as a result of ASPA, is deteriorating material condition, rapidly escalating number of field teams in service repairs (ISR), deteriorating ASPA results, and rapidly escalating organizational level man-hours. The service life of the P-3 has been extended from 30 years to 50 years with the cancellation of the P-7/P-3H. No replacement aircraft is currently planned for the P-3.

RCM and age exploration analysis of historical data determined the depot requirements under PDM. The P-3 PDM interval was set at four years. After four years, maintenance man-hours/per flight hour began to increase. Additionally, under ASPA the original paint protection had eroded and was a significant factor in the further deterioration in the material condition of the aircraft. The PDM interval of four years will ensure that proper paint protection is applied with consistency.

The PDM cycle for the P-3 aircraft consists of three phases at four year interval for each phase. Figure 11 displays the three phases of the PDM cycle and what is accomplished at each phase.

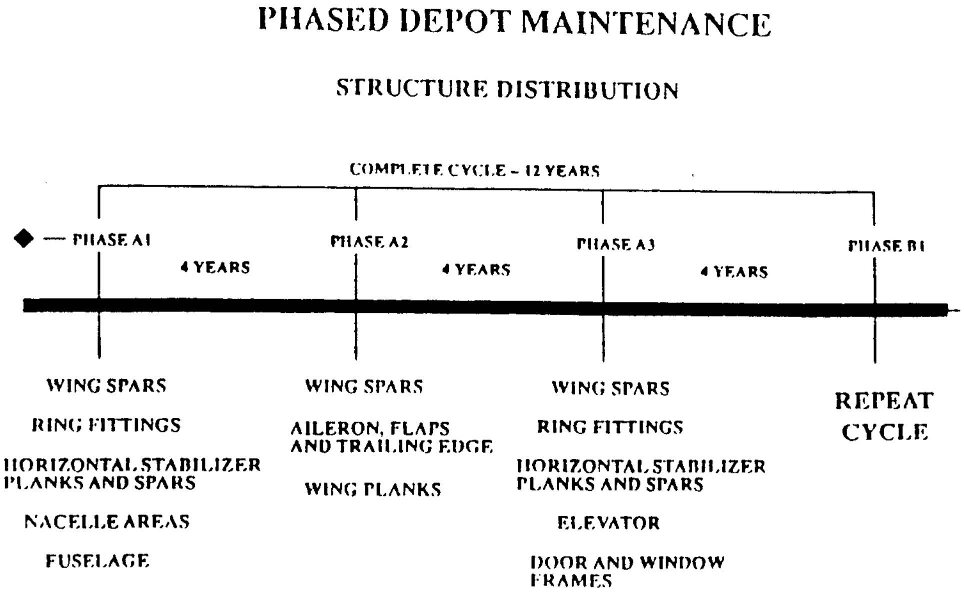

Figure 11. The P-3 PDM Cycle

The P-3 will be inducted into depot three times in 12 years rather than one time in ten years. To obtain a valid sampling, the Navy used sample prototypes comprised of aircraft in both good and poor material condition. Based on the P-3 data, we feel the Navy should consider a PDM prototype program on the F-14. Additionally, F-14 historical data and other information will need to be collected before a PDM prototype decision could be made. This is beyond the scope of this thesis.

G. PREVIEW

Chapter IV will compare the ASPA and PDM sample data for the F-14 and F-15. We will discuss trends in budget costs, depot completions and ASPA deferral rates from fiscal years 1991 to 1994. An explanation of the Logistic Support Analysis to determine the future consequences of the ASPA process.

IV. ANALYSIS OF ASPA AND PDM DATA

A. INTRODUCTION

This chapter will attempt to compare the ASPA and PDM sample data for both aircraft. A projection analysis on how these respective depot maintenance philosophies impact their respective service, specifically in the areas of cost and aircraft maintenance intervals.

B. INDUCTION DEFERRAL RATES

This section analyzes the F-14 ASPA deferral rates from fiscal years 1991 to 1994 to detect patterns in post ASPA inspection induction deferral over this period. PED extensions of up to one year can be given for those aircraft that successfully pass an ASPA inspection. Under ASPA, aircraft may receive numerous deferrals, as a result, aircraft tour lengths would increase significantly. An example of these deferrals can be seen in the last four columns of Table 4 which provides for 39 F-14 bureau numbers the actual number of deferrals on each aircraft.

The ASPA inspection data provides the results of 665 inspections conducted by depot personnel at organizational and airwing sites during the four year period from 1991 to 1994. Figure 12 represents F-14 deferral rates by tour. These deferral rates were collected on aircraft from both east and west coast Naval aircraft.

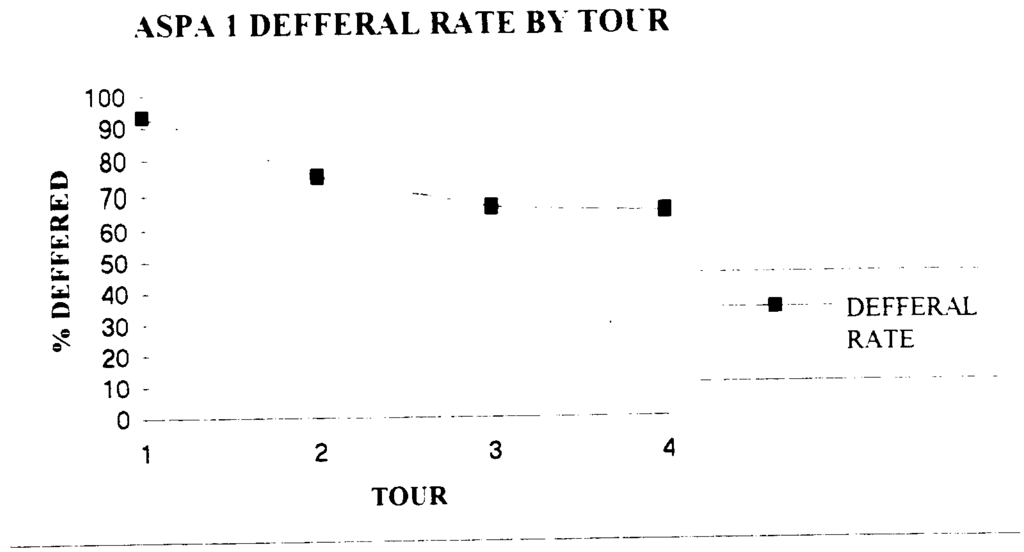

Figure 12. ASPA Deferral Rates by Tour

These inspections over extended periods account for increased costs and hours at the organizational and depot levels. For example, these 665 inspections over four years cost an estimated \$1.7 million. This amount does not account for squadron time expended for pre and post ASPA corrections which are likely to be significant. These man-hours and dollars could be utilized more effectively, if the ASPA inspection was eliminated and a firm induction process is implemented.

Table 1 shows the deferral rate is highest for first tour aircraft. These first tour aircraft have a deferral rate of 93.26 percent. The deferral rate steadily declines as the aircraft ages and the number of tours increase from one to four. This is graphically displayed in Figure 12.

ASPA 1

TOUR	1	2	3	4
TOT A/C INSPECT	178	109	122	23
TOT DEFFERED	166	82	81	15
DEFFERAL RATE	93.26	75.23	66.39	65.22

ASPA 2

TOUR	1	2	3	4
TOT A/C INSPECT	102	24	32	5
TOT DEFFERED	86	17	24	3
DEFFERAL RATE	84.31	70.83	75	60

ASPA 3

TOUR	1	2	3	4
TOT A/C INSPECT	37	10	12	0
TOT DEFFERED	26	5	6	0
DEFFERAL RATE	70.27	50	50	0

ASPA 4

TOUR	1	2	3	4
TOT A/C INSPECT	8	1	1	0
TOT DEFFERED	7	0	0	0
DEFFERAL RATE	87.5	0	0	0

ASPA 5

TOUR	1	2	3	4
TOT A/C INSPECT	1	0	0	0
TOT DEFFERRED	0	0	0	0
DEFFERAL RATE	0	0	0	0

Table 1. ASPA 1 Deferral by Tour

The data from Table 1 indicates that the average number of F-14 ASPAs per tour is two to three. This means that the aircraft has served it's 56 month service period plus two or three 12 month extensions. This equates to an aircraft remaining in the fleet greater than seven years before it is inducted for a SDLM. These deferral rates are accepted practice for Navy aircraft.

As the deferral rates increase, meaning the aircraft is in service longer, the material condition of the aircraft degrades. These deferral rates are directly related to the amount of time that aircraft remain without depot service and are contributing to the poor material condition of the aircraft as they enter the depot.

C. SDLM COSTS

Chapter III discussed in detail the problems being experienced by Navy maintenance personnel to keep the aging fleet of F-14s in service. These problems are specifically more hours of preventive and corrective corrosion work performed as part of their routine phase inspections. The deferral of depot maintenance as standard practice has exacerbated many of these problems. The costs of deferring depot inductions is particularly evident when one traces the rising costs of SDLMs from fiscal year 1991 to 1994 and displays in monetary terms and increased man-hours the impact of continuous ASPA deferrals. Additionally, no time value of money was added to the comparison, all dollars are displayed in 1993 values.

Figure 13 shows graphically the total SDLM cost of 39 F-14s that were inducted to NADEP Norfolk from 1991 to 1994. The 39 points were plotted in sequence from 1991 through 1994 and a linear regression line was fit through the points to display trends in the data series. The R squared value shows some relationship between the trendline and the data points. The trendline has a positive slope that implies an increase in cost from 1991 to 1994. The variability in the data points is obvious as the low and high points range from $1,127904 to $2,711,617. This variability of costs to get an aircraft back to the proper material condition once inducted displays the degraded and mixed condition of the F-14 fleet and a depot induction process that is not in control.

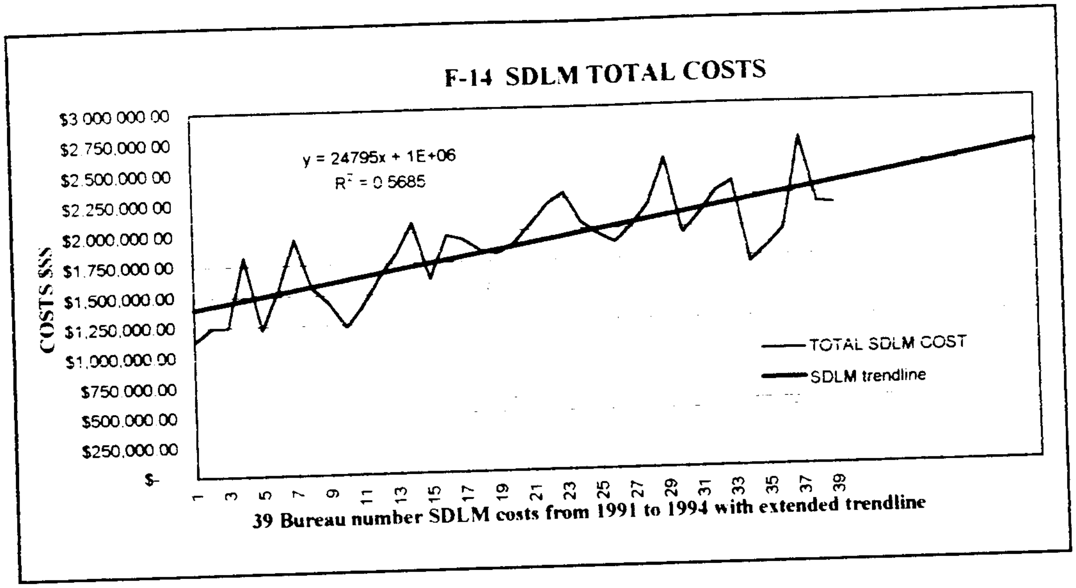

Figure 13. F-14 SDLM Costs With Extended Trendline

Figure 13 extends this trendline to display the impact of increased costs into the future. This direction if not reversed would put the cost of an aircraft to go through SDLM in excess of 3 million dollars by the year 2000 using 1993 dollars.

While all rework facilities nationwide both commercial and military are experiencing increased costs due to countless variables inherent to this type of work. This F-14 increase in costs represents too severe a growth trend to attribute totally to outside uncontrolled factors such as labor rate increases, contract changes, and inflation plaguing all similar maintenance efforts. The commercial airline maintenance industry survives on their aggressive maintenance programs and continual efforts to control costs. The airline industry adheres to firm inductions for maintenance because it provides the best service to their fleet in the short term and amortizes their costs over the life cycle of their aircraft.

Expended SDLM man-hours		
ACFT	induct/yr	act hrs/avg
F-15	1991	8,212
F-14	1991	23,812
DIFFERENCE 'TOTAL		15,600
F-15	1993	12,355
F-14	1993	29,170
DIFFERENCE 'TOTAL		16,815

Table 2. F-14 and F-15 Expended SDLM Man-hours

Table 2 shows both the F-14 aircraft in terms of expended man-hours to complete depot rework for an F-14 and F-15 aircraft. The hours to complete an F-14 are almost three times as great as an F-15 in 1991. While the F-15 experienced increased man-hours in 1993, the hours to complete an F-14 are more than double that of the F-15. One factor for this increased workload requirement on the F-14 is the inferior material condition upon induction when depot maintenance is finally conducted.

D. ANALYSIS OF THE F-14 AND F-15 DATA

1. Qualifying the Data

We visited Robins AFB in Warner Robins, GA to review and analyze the Air Force's F-15 program. This aircraft was selected since it is comparable to the Navy's F-14 in many ways. Both aircraft are similar in age, the F-14 began service in 1972 and the F-15 in 1976. The two aircraft are fighters, both have similar missions and like designs, and both are dual engine aircraft. It is true that the operating environments of the two

services are very different in that the rigors of carrier flight operations is more damaging to the aircraft. The data received encompasses all the aspects of depot maintenance to include man-hours expended, material costs to repair, and detailed summations of the estimates for each of these categories.

Table 3 depicts the data collected on the F-15 during this visit. It shows the number of aircraft inducted for 1991 and 1993 as well as the actual average hours to complete those aircraft.

The data contained in Table 4 was received in June of 1994 from NADEP Norfolk. The data received encompasses all the aspects of depot maintenance to include man-hours expended, material costs to repair, and detailed summation of the estimates for each of these categories. Table 4 represents a collection of maintenance data on actual Navy F-14 bureau numbers that underwent depot level maintenance between October 1991 to December 1994. The sampling consists of 39 F-14 aircraft and is comprised of both the F-14A,B models presently in the fleet. This sample size represents 8.3 percent (39/472) of the actual population of F-14s being flown in the Navy as of January 1994.

F-15 PDM Analysis					
ACFT.	year	NBR inducted	avg.actual hrs.	Labor rate	Nif cost
F-15	1991	34	8,212.00	$ 71.62	$ 588,143.44
F-15	1993	44	12,355.00	$ 71.62	$ 884,865.10

Table 3. F-15 PDM Data for Bureau Numbers in 1991 and 1993

F-14 ASPA Analysis

ACFT	# in inv	% in inv	# in sam	rounding	% in sam
F-14A	353	0.747881356	37.3940678	37	0.74
F-14-B	66	0.139830508	6.991525424	7	0.14
F-14-D	53	0.112288136	5.61440678	6	0.12
total	472			50	N=472 n=39

TypeAC	sample	buno	induction/yr	est mnhrs	actual hours	var/labor	mat cost/est	mat cost/actual	var/material $	Nif cost	Labor rate	tour #	age/mo	ASPA # when inducted	ASPA months
F-14	1	159017	1991	20,385.00	22,437.00	(2,052)	$ 318,333.00	$ 258,875.00	$ 59,458.00	$ 1,127,904.00	50.27	4	224	no info	no info
F-14	2	161147	1991	18,124.00	22,413.00	(4,289)	$ 439,208.00	$ 325,671.00	$ 113,537.00	$ 1,240,985.00	55.37	2	112	1	12
F-14	3	161164	1991	19,707.00	21,263.00	(1,556)	$ 457,778.00	$ 421,740.00	$ 36,038.00	$ 1,247,059.00	58.65	2	112	1	12
F-14	4	159454	1991	20,311.00	29,074.00	(8,763)	$ 503,000.00	$ 604,315.00	$ (101,315.00)	$ 1,821,871.00	62.66	4	224	1	12
F-14	5	161150	1991	19,101.00	20,809.00	(1,708)	$ 310,269.00	$ 332,760.00	$ (22,491.00)	$ 1,217,341.00	58.50	2	112	1	12
F-14	6	159457	1991	18,097.00	25,455.00	(7,358)	$ 345,553.00	$ 439,952.00	$ (94,399.00)	$ 1,540,597.00	60.52	3	168	1	12
F-14	7	159606	1991	20,311.00	30,545.00	(10,234)	$ 439,208.00	$ 639,533.00	$ (200,325.00)	$ 1,957,956.00	64.10	3	168	1	12
F-14	8	161281	1991	14,675.00	23,254.00	(8,579)	$ 495,697.00	$ 509,074.00	$ (13,377.00)	$ 1,562,132.00	67.18	2	112	1	12
F-14	9	161850	1991	16,846.00	24,207.00	(7,361)	$ 304,581.00	$ 355,653.00	$ (51,072.00)	$ 1,433,163.00	59.20	1	56	3	36
F-14	10	161853	1991	15,114.00	18,546.00	(3,432)	$ 374,522.00	$ 399,229.00	$ (24,707.00)	$ 1,229,858.00	66.31	1	56	3	36
F-14	11	161857	1991	15,742.00	23,929.00	(8,187)	$ 313,214.00	$ 341,123.00	$ (27,909.00)	$ 1,398,763.00	58.45	1	56	2	24
F-14	12	161861	1991	15,531.00	26,558.00	(11,027)	$ 333,617.00	$ 428,933.00	$ (95,316.00)	$ 1,636,819.00	61.63	1	56	2	24
F-14	13	160389	1992	18,124.00	30,197.00	(12,073)	$ 439,208.00	$ 511,992.00	$ (72,784.00)	$ 1,826,647.00	60.49		no info	no info	no info
F-14	14	160411	1992	18,124.00	31,443.00	(13,319)	$ 432,000.00	$ 645,358.00	$ (213,358.00)	$ 2,074,780.00	65.99	3	168	1	12
F-14	15	161868	1992	18,124.00	27,263.00	(9,139)	$ 364,420.00	$ 410,129.00	$ (45,709.00)	$ 1,614,387.00	59.22	1	56	2	24
F-14	16	161860	1992	18,124.00	28,333.00	(10,209)	$ 432,000.00	$ 681,834.00	$ (249,834.00)	$ 1,966,204.00	69.40	1	56	2	24
F-14	17	160386	1992	18,124.00	32,385.00	(14,261)	$ 364,420.00	$ 497,094.00	$ (132,674.00)	$ 1,933,297.00	59.70	no info	no info	no info	no info
F-14	18	160390	1992	18,124.00	29,848.00	(11,724)	$ 364,420.00	$ 464,568.00	$ (100,148.00)	$ 1,839,595.00	61.63	3	168	1	12
F-14	19	161855	1992	18,124.00	29,790.00	(11,666)	$ 315,000.00	$ 474,388.00	$ (159,388.00)	$ 1,812,531.00	60.84	1	56	2	24
F-14	20	161858	1992	18,124.00	28,516.00	(10,392)	$ 432,000.00	$ 610,794.00	$ (178,794.00)	$ 1,888,807.00	66.24	1	56	2	24
F-14	21	161859	1992	18,124.00	32,540.00	(14,416)	$ 439,208.00	$ 561,667.00	$ (122,459.00)	$ 2,044,146.00	62.82	1	56	2	24
F-14	22	161284	1993	18,124.00	30,363.00	(12,239)	$ 432,000.00	$ 826,597.00	$ (394,597.00)	$ 2,204,405.00	72.60	2	112	2	24
F-14	23	161603	1993	18,374.00	33,269.00	(14,895)	$ 424,582.00	$ 614,948.00	$ (190,366.00)	$ 2,296,878.00	69.04	1	56	3	36
F-14	24	162600	1993	18,124.00	31,556.00	(13,432)	$ 432,000.00	$ 621,925.00	$ (189,925.00)	$ 2,050,086.00	64.97	1	56	1	12
F-14	25	162691	1993	18,374.00	27,179.00	(8,805)	$ 424,582.00	$ 494,002.00	$ (69,420.00)	$ 1,956,287.00	71.98	1	56	2	24
F-14	26	162700	1993	18,374.00	26,702.00	(8,328)	$ 424,582.00	$ 411,899.00	$ 12,683.00	$ 1,885,117.00	70.60	1	56	2	24
F-14	27	161607	1993	18,374.00	25,837.00	(7,463)	$ 424,582.00	$ 602,702.00	$ (178,120.00)	$ 2,016,981.00	78.07	1	56	3	36
F-14	28	161609	1993	18,374.00	31,363.00	(12,989)	$ 424,582.00	$ 506,284.00	$ (81,702.00)	$ 2,188,913.00	69.79	1	56	3	36
F-14	29	161621	1993	18,374.00	31,239.00	(12,865)	$ 424,582.00	$ 843,760.00	$ (419,178.00)	$ 2,559,593.00	81.94	1	56	3	36
F-14	30	162599	1993	18,374.00	27,644.00	(9,270)	$ 424,582.00	$ 434,861.00	$ (10,279.00)	$ 1,947,377.00	70.44	1	56	2	24
F-14	31	162692	1993	18,374.00	27,606.00	(9,232)	$ 424,582.00	$ 566,071.00	$ (141,489.00)	$ 2,097,545.00	75.98	1	56	3	36
F-14	32	160382	1993	18,374.00	31,750.00	(13,376)	$ 424,582.00	$ 550,492.00	$ (125,910.00)	$ 2,282,998.00	71.91	3	168	3	36
F-14	33	160407	1993	18,374.00	32,803.00	(14,429)	$ 424,582.00	$ 590,394.00	$ (165,812.00)	$ 2,362,124.00	72.01	3	168	2	24
F-14	34	162603	1993	18,374.00	24,522.00	(6,148)	$ 424,582.00	$ 385,524.00	$ 39,058.00	$ 1,693,551.00	69.06	1	56	2	24
F-14	35	162604	1993	18,124.00	27,535.00	(9,411)	$ 432,000.00	$ 527,273.00	$ (95,273.00)	$ 1,823,992.00	66.24	1	56	1	12
F-14	36	162693	1993	18,374.00	28,195.00	(9,821)	$ 424,582.00	$ 453,443.00	$ (28,861.00)	$ 1,964,531.00	69.68	1	56	3	36
F-14	37	160403	1994	18,124.00	39,587.00	(21,463)	$ 432,000.00	$ 1,087,946.00	$ (655,946.00)	$ 2,711,617.00	68.50	3	168	1	12
F-14	38	162597	1994	18,374.00	31,093.00	(12,719)	$ 424,582.00	$ 567,114.00	$ (142,532.00)	$ 2,176,299.00	69.99	1	56	2	24
F-14	39	162603	1994	18,374.00	30,579.00	(12,205)	$ 424,582.00	$ 576,028.00	$ (151,446.00)	$ 2,164,033.00	70.77	1	56	2	24

Table 4. F-14 ASPA Analysis Spreadsheet

2. The F-14 Average Fleet Aircraft

The data from Table 5 shows the average F-14 data profile of 39 aircraft. Most notable is the F-14 hours of 28,144 per SDLM and the cost of 1,866,594.08 dollars. These figures represent a significant expenditure in manpower and dollars for the Navy to get an aircraft through the depot process. Additionally, the number of deferrals discussed in Section A of this chapter reaffirm that the average fleet aircraft experiences two to three deferrals before induction. From interviews of inspectors at NADEP Alameda (P-3) and NADEP Norfolk, revealed that in their experience that the usual number of ASPAs done on an aircraft was three by the time it was inducted.

F-14 AVERAGE AIRCRAFT PROFILE		
AVERAGE OF 39 AC		
AVG. TOUR #		1.675
AVG. AGE IN MONTHS		93.8
AVG. # OF SDLMS		2
AVG. # OFMO. TO INDUCT		23
AVG. HOURS PER SDLM		28,144
AVG. MATERIAL COST	$	527,588.33
AVG. TOTAL SDLM COST	$	1,866,594.08

Table 5. The F-14 Average Aircraft Profile

E. PROJECTION ANALYSIS OF THE F-15 AND F-14 MAINTENANCE CYCLES

1. Comparisons

The following section is a comparison of a typical Air Force F-15 and a Navy F-14 under the PDM and ASPA Programs, respectively. This analysis is performed to clearly display the impact that depot induction procedures can have on the frequency of maintenance performed and ultimately the material condition of the aircraft.

2. F-14 and F-15 1993 Data

The following data for Table 6 is taken from Tables 3 and 4 and represents 1993 data for both the F-14 and the F-15 aircraft. The key figures for each aircraft are the average hours per SDLM, as well as the cost. For comparison the labor rate from Norfolk of $71.62 was used for both aircraft. This data will be used to make comparisons for 1993 and provide insights into future year trends.

F-14 AVERAGE FY 1993 PROFILE		
AVERAGE OF15 AC		
AVG. # OF ASPA DEFERRALS		2.3
AVG. # OFMO. TO INDUCT		28
AVG. LBR. RATE(NORFOLK)	$	71.62
AVG. HOURS PER SDLM		29,170
AVG. TOTAL SDLM COST	$	2,088,691
F-15 AVERAGE FY 1993 PROFILE		
AVERAGE OF44 AC		
PDM CYCLE (mo)		72
AVG. LBR. RATE(NORFOLK)	$	71.62
AVG. HOURS PER SDLM		12,355
AVG. TOTAL SDLM COST	$	884,865

Table 6. Aircraft 1993 Profile of F-14 and F-15

3. Comparative Assumptions

For consistency, the average depot rate of 1993 ($71.26) for NADEP Norfolk was used for both depots due to the fluctuations in geographic region, inflation, and contract changes. No attempts were made to factor out the age of the aircraft in any of our calculations, as an in-depth cost analysis involving age factors is beyond the time constraints of this project.

4. The F-14 Cycle

Figure 14 displays a time line of an F-14 aircraft and the maintenance actions that will occur in the years 1993 to 2006.

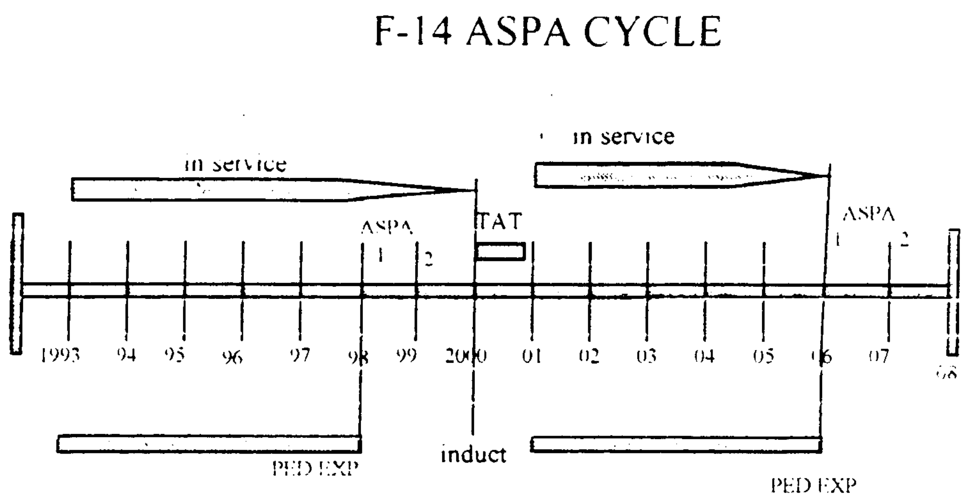

Figure 14. The F-14 ASPA Cycle

During this timeframe both aircraft entered service in 1993 directly from each of the respective depots. The F-14 goes through the typical PED of 56 months and in 1998 the PED expires making it a candidate for ASPA 1. This F-14 goes through two extensions, and is a candidate for depot rework in the year 2000. It enters SDLM in the year 2000 and experiences close to a year (300 days average) turnaround time, as referenced in Chapter III. The aircraft returns to the fleet in the year 2001 and remains in service until the expiration of its PED in the year 2006 at which time the ASPA inspection process begins again. The average F-14 remains in the fleet another two to three years before it is ultimately inducted again.

Table 7 displays the costs in terms of dollars spent and man-hours for the one F-14 SDLM performed during the analysis time period.

F-14 ASPA CYCLE SUMMATION		
induction/yr	cost	hours
2000	$ 2,088,691.87	29,170
total	$ 2,088,691.87	29,170

Table 7. F-14 ASPA Cycle Cost Summation for One SDLM

5. The F-15 Cycle

Figure 15 displays the typical, F-15 aircraft under the PDM Program from the year 1993 to 2006.

F-15 PDM CYCLE

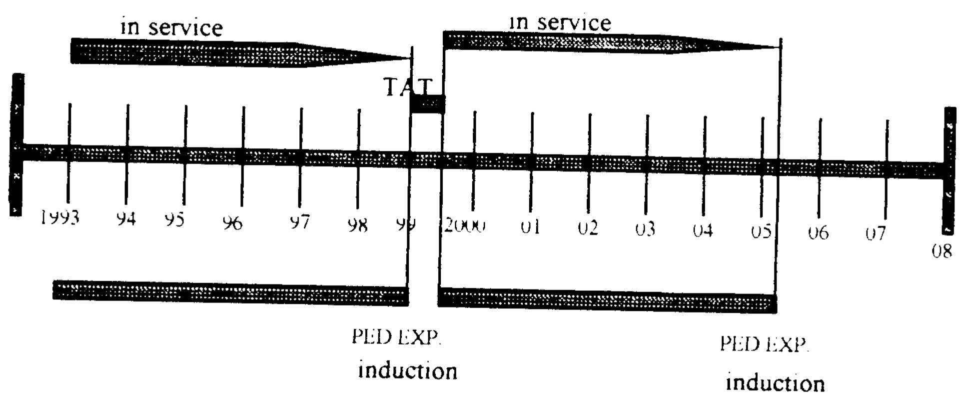

Figure 15. F-15 PDM Cycle

The F-15 has an operating service period of six years and is inducted in the year 1999 for rework. Following the average turnaround time of around 100 to 120 days, the aircraft returns to service for another six years where it is ultimately inducted between the year 2005 to 2006.

The TAT for the F-15 is significantly lower than the F-14 since its induction to the depot is on a firm basis and not subject to deferrals. This is inherent in firm induction programs as the maintenance teams do not have to perform all aspects of depot

maintenance in one cycle. Rather there can be a better scheduling of all the particular aspects of maintenance, as the aircraft will be returning to the depot on a regular interval.

F-15 PDM CYCLE SUMMATION			
induction/yr		cost	hours
1999	$	884,865.10	12,355
2005+	$	884,865.10	12,355
TOTAL	$	1,769,730.20	24,710

Table 8. F-15 PDM Cycle Cost Summation for Two PDMs

Table 8 displays the comparable costs for the F-15 aircraft in terms of man-hours and depot dollars for the 2 SDLMs performed..

6. Projection Analysis Realization

The results of this projection are that the F-15 is inducted for two PDMs to every one SDLM induction for the F-14. The F-15 aircraft is not only seen in this comparison one more time by their respective depot but actually costs $318,961.60 less to perform. The inherent problems associated with the absence of a firm depot induction policy caused by the ASPA Program would all be addressed by removing the variability of the present depot induction philosophy on the F-14 aircraft. Referenced in Chapter III, the increased depot TAT, scheduling variability, and organizational workload increase could all be significantly reduced with the PDM Program or any program that incorporates some firm set induction period.

The message in this comparison is clear, a firm induction process for depot maintenance increases the quality in material condition due to more frequent attention given to that particular aircraft. Additionally, these more frequent intervals cost less to perform as the total cost of maintaining these aircraft are amortized over more frequent inspections/inductions rather than one significant costly maintenance effort. The Logistic Support Analysis (LSA) concept confirms the theory that firm induction period will always outperform a system that possesses increased variability in their process.

The LSA concept is an invaluable tool that involves a continuous ongoing effort to analyze all aspects of a weapons system to arrive at cost effective methods for areas such as: the correct blend of preventive and corrective maintenance actions and initial supportability requirements to name a few. Further explanation of how LSA concept is tied to the Integrated Logistics Support Plan (ILS) can be found in Appendix B.

The Navy needs a comprehensive plan to get their aircraft on a firm induction schedule. This LSA concept provides the framework in which to establish this comprehensive plan of set depot inductions. The logisticians should analyze the maintenance data to validate the correct OSP period for the aging F-14 and establish a firm induction process based solely on the OSP.

F. PREVIEW

The concluding chapter includes the Summary, Recommendations, and Conclusions.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

This thesis has focused on the impact the ASPA program has had on the organizational and depot levels of maintenance using the F-14 aircraft as an example. The analysis has centered on material and labor costs, schedule and planning impact, material condition, parts support, organizational and depot workload and turnaround time under the ASPA program.

We have found that terminating the ASPA program will significantly reduce the major cost drivers attributable to its variabilities and uncertainties in TAT, work schedule and manpower planning. Additionally, the potential to retard material condition degradation due to administratively extended Operating Service Periods and reduce the workload at the squadrons and the "over and above" workload at the depots will be significant.

It is clear that adopting a firm induction schedule solely based on strict adherence to a specified operating service period such as the Air Force's PDM program will achieve the desired results. The notion of a firm induction schedule as a means of achieving tighter control of the depot process variables is supported by MILSTD 1388, the Logistics Support Analysis.

In order to establish the framework for analyzing the F-14 and the F-15 aircraft, we presented the background and general overview of the ASPA and PDM programs. We analyzed data from fiscal years 1991 to 1994 and developed a projection analysis model to determine the frequency of depot maintenance performed on the aircraft, labor hours required to complete a SDLM and the total SDLM cost. Our analysis has shown that increasing the frequency of depot inductions based on a firm schedule will decrease the variables, cut duplicate inspection efforts, improve the average condition of airplanes at induction and cut costs. Moreover, as in the P-3 PDM example, the environmental protection system (paint, primers, coatings etc.) will

be renewed more frequently, decreasing the squadron workload, reducing corrosion, and eliminating the "calico" appearance of tactical Navy airplanes.

B. CONCLUSIONS

From our analysis, we conclude the following:

1. The average workload per F-14 aircraft increased by 9,712 from 24,041 hours in 1991 to 33,753 hours in 1994.

2. The ASPA program introduces uncertainty in parts support, material condition, labor content, flow time and scheduling during the SDLM process.

3. In addition to the above, there are associated rising costs for SDLM's.

4. Eliminating ASPA will promote accuracy, streamlining and process control of depot and modification induction planning, budget planning, scheduling and resource analysis for Assistant Chief of Naval Operations (ACNO) for Air Warfare, controlling custodians, NAVAIR, the depots and the squadrons.

5. Adoption of the PDM process will minimize the subjectivity inherent in the ASPA program.

C. RECOMMENDATIONS

We recommend the following course of actions:

1. Eliminate the ASPA program for all Navy aircraft. This will lead to the reduction of the uncertainty and variability in the process. This elimination of the variability will reduce TAT, expended man-hours, organizational workload and material and labor costs.

2. Use the P-3 PDM prototype program as a model for developing the F-14 PDM program.

3. We recommend a PDM interval be established for depot induction. This interval must be analyzed and reviewed on a regular basis, similar to the Air Force's CIE program. It must be adjusted to achieve effective process control.

The general material condition of the F-14 was the basis for this study. Further research will show the F-14 situation is not unique.

Our study did not examine such factors as the impact of ASPA on operational readiness. The authors recognize that there are also many areas of depot maintenance such as detailed cost accounting and repair or replace decisions that warrant further study.

APPENDIX A.

A. NAVAL AVIATION MAINTENANCE STRUCTURES

All Naval Aviation Maintenance is broken down into three levels: organizational, intermediate, and the depot levels. This three tier maintenance concept allows for an extensive intermediate component repair concept to accompany the Naval Air Wings while deployed aboard a carrier. The depot level is heavy equipment oriented and has the specialized talents and equipment to allow for a complete overhaul of fleet aircraft but still maintain control and expertise organic to the Navy. (DON, July 1991)

1. The Organizational Level

Organizational level maintenance is normally performed by an operating unit on a day to day basis in support of its own operation. The goal of all organizational level maintenance is to maintain the aircraft in a full mission capable status while continually improving the local maintenance process.

Organizational level functions can be defined under the following categories:

1. Report preparation
2. Inspections
3. Record keeping
4. Incorporate TD's
5. Preventive maintenance
6. Handling
7. Servicing
8. Corrective maintenance

2. The Intermediate Level

The intermediate level of maintenance is performed by designated maintenance activities in direct support of the organizational levels. The mission of the Intermediate level is to enhance and sustain the combat readiness and mission capability of the organizational level by providing quality and timely material support and component repair. The total maintenance sphere of the intermediate level consists of on and off equipment material support to include:

1. Component repair
2. Manufacture of selected components
3. Perform aircraft maintenance when required
4. Age exploration under RCM
5. Incorporation of TD's
6. Component processing
7. Calibration for O & I-levels
8. Technical assist to O-levels

3. The Depot Level

The depot level maintenance is performed at Naval Aviation Industrial establishments to assure the continual flying integrity of airframes and flight systems. Depot level maintenance is an extensive level of maintenance usually involving major overhaul or rebuilding of parts or components. The capabilities of depot level include the manufacture, modification, testing, inspecting, sampling and reclamation of aircraft parts.

The purpose of depot level is to support the lower levels of maintenance by providing engineering assistance and performing maintenance that is beyond the capabilities of organizational or intermediate levels.

The functions of depot level maintenance may be defined as:

1. Complete overhaul of aircraft
2. Manufacture or modification of engines, aircraft, and support equipment
3. Technical and engineering assist
4. Age exploration under RCM
5. Incorporate TD's
6. Manufacture or modify parts kits
7. Repair and rework components and support equipment
8. Repair and rework engines
9. Calibration

B. AIR FORCE STRUCTURE

In more recent years, the Air Force has evolved into a truly two tier maintenance system. That is, they have the significant portion of component repair done at specialized organizational levels and if needed they are assisted by specialists at the depots.

In order to meet the specific maintenance requirements of major weapons systems, the Navy and Air Force have each adopted their own unique Maintenance Programs. Realizing the different and distinctive missions these services are required to perform, both interestingly enough have similar maintenance structures set up to deal with their respective missions.

The two services operate in completely opposite environments. To a degree some of the maintenance philosophies and practices have been shaped by the environments in which they function. Obviously, the Navy had to adopt maintenance procedures that would deal with their extremely corrosive environment at sea. Meanwhile, the Air Force operates in many cases with a much more stable dry environment. These factors and many more have shaped the respective maintenance concepts of the services.

Both services have a talented infrastructure and most of the resident specialization for this is housed at their respective depot maintenance facilities.

Both services are being forced to continue flying aircraft that were never intended for such extended years of service. Because of this there is a great need for an extremely efficient maintenance infrastructure that can essentially rejuvenate and extend the service life of specific major platforms.

APPENDIX B.

A. THE DEVELOPMENT OF A MAINTENANCE PLAN

This thesis deals specifically with Naval and Air Force maintenance philosophies and practices for the depot level rework of their Aviation branches. To truly understand how a changing of a procedure in any level of maintenance will affect the total logistics plan, one must first understand how the services derive the total Integrated Logistics Support Plan (ILS) for the aircraft. The Logistics Support Analysis (LSA) Concept is a tool that utilizes all the aspects of the data analysis to better derive procedures and plans of support. With this better understanding of the ILS Plan and how it is derived using the tools of LSA, a more efficient evaluation of any change in maintenance procedures will impact the total effectiveness of that services maintenance efforts.

The maintenance concept of a weapons system is developed from operational and planning considerations early in the design phase of a system. As the system progresses through the early phases of development, these inherent restraints and limitations in the design have a direct effect on the reliability and maintainability. From the initial design requirements, the designer and manufacturer realize the positive aspects of the weapons system's performance along with its limitations. Within these limitations and design environment the maintenance program is established. Therefore, they pattern the maintenance concept of a weapons system with the following considerations:

1. Operational and maintenance environment in which it will operate.
2. The required availability rate.
3. The planned utilization rate.
4. The frequency of maintenance (scheduled and unscheduled).
5. The quality assurance philosophy needed to provide adequate support.
6. The availability of personnel and skills.
7. The previous experience with similar systems and equipment.

8. The design and maintainability goals of the user.

9. Always the cost and time limitations.

Three critical areas of the maintenance program are: reliability, maintainability, and the maintenance requirements. They must be developed concurrently to predict and produce a realistic and manageable maintenance program. Reliability is a design characteristic based on failures per unit of time. Maintainability is also a design characteristic that relates to the degree of ease or the degree of difficulty in performing maintenance on the system.

The maintenance requirements are a direct result of reliability and maintainability achieved in the design phase. These maintenance requirements will dictate to a great extent the maintainability goals of the user organization.

Once these reliability and maintainability goals have been established and met to the satisfaction of all involved, they will dictate the maintenance requirements through a systems life cycle.

The summation of factors considered in the evolution of a maintenance philosophy includes:

1. Planned maintenance levels needed
2. Common or peculiar support equipment
3. Maintenance task aids
4. Special skills
5. Fault isolation, repair, and verification
6. Turnaround inspection
7. Servicing
8. Mission loading
9. Mission configuration
10. Operational turnaround time
11. Scheduling maintenance levels
12. Component repair

13. Manpower factors

This Maintenance Plan is an integral part of the overall Integrated Logistics Support (ILS) Plan. This ILS plan is an orderly procedure to be followed during the programmed life cycle of the airframe, from the initial requirements generation through the actual production.

Therefore, each phase of the life cycle and therefore each phase of the ILS Plan must consider all the elements of support, including maintenance.

The interdependence of the Operational Concept, Maintenance Concept, and the ILS Plan can not be overemphasized. It should be obvious that a change in any one of these will ultimately impact the factors involved in the other three.

Once the maintenance concept has been established for all levels of maintenance it is essential that a change in any factor be considered only in terms of the total integrated system support.

Any change in the maintenance concept for organizational, intermediate or depot level must be considered in the total sphere of integrated system support. It is a reasonable conclusion that a change in one factor will have some impact on some other area of the operational or maintenance support plan.

That is one of the theories of this thesis. There was a very definite departure in the maintenance practice by deferring depot inductions. This departure in and of itself is not to be considered a negative undertaking. However, to make this change without considering how this change effected the total Logistics plan is not in the best interest of support for the weapons system.

LIST OF REFERENCES

Air Force Material Command, "Air Logistics Centers," *Leading Edge*, p. 33, July 1994.

Ballou, R.H., *Business Logistics Management,* Third Edition, Englewood Cliffs, NJ: Prentice Hall, 1992.

Borchers, Wayne Peter and Rowan, Richard Michael, *Quantification of the S-3 Viking Aircraft Service Period Adjustment (ASPA) Program,* Master's Thesis, Naval Postgraduate School, Monterey, CA December 1986.

Center For Naval Analysis, *ASPA and the Effect of Deferred Depot Maintenance on Airframe Rework Cost,* by Robert Levy, Operations and Support Division, March, 1991.

Department of the Navy, *Operational Navy Instruction (OPNAVINSTR) 4790.2E, Naval Maintenance Instruction,* July 1991.

Interview between Jim Vanderwende, Naval Aviation Depot Operation Center, (NADOC), (04), and Robert G. Ramsey, Lieutenant Commander, USN, October, 1994.

Interview between Bob Bauer, Supervisor, Delta Airlines Maintenance, Dallas, Texas, and Robert G. Ramsey, Lieutenant Commander, USN, August 1991.

Naval Air Systems Command, *Navy Model F-14A & F-14B Aircraft, Analytical Maintenance Program Standard Depot Level Maintenance SDLM Specification,* by Direction of Commander, (NASC), February, 1992.

United States Air Force, *Air Force Technical Order* AFTO 00-25-4. *Depot Maintenance of Aerospace Vehicles and Training Equipment,* 15 May 1988.

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